Based on fragmentary material, *Progyrolepis* can be only incompletely defined at this time. In consequence, certain doubts as to the exclusiveness of its definition and to the relationships of the form probably must be still entertained. The genus bears strong resemblances to the elonichthyids, the palaeoniscids, and the pygopteryids. These three families apparently represent the, as yet, quite tentative grouping of a number of closely allied genera whose interrelationships have not been entirely worked out. The combination of morphological features outlined in the foregoing generic characterization is suggestive of an interesting early attainment of the structural condition of the Triassic paleoniscid *Pteronisculus*, and has prompted the present interpretation of structure in support of the recent assignment of *Progyrolepis* to the restricted family Palaeoniscidae (Romer, 1945b).

In conclusion, while certain enticing paleogeographical questions are presented by the occurrence of presumably the same genus almost contemporaneously in both the eastern and western hemispheres, speculation on the points seems useless until the genus is more adequately understood.

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ICHTHYOLOGY.—Gila cypha, *a remarkable new species of cyprinid fish from the Colorado River in Grand Canyon, Arizona.*[1]

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The fish fauna of the vast Colorado River Basin of western North America is the least well known of the major drainages of the West. Our knowledge of the ichthyology of this river began with the surveys during the middle of the last century by Captain Sitgreaves, the Pacific Railroad Surveys, and by the United States and Mexican Boundary Survey. Since that time, however, only one of its major tributaries, the Gila River of southern Arizona, has been moderately well explored throughout for fishes, and even in that comparatively small watershed the job is incomplete. The greater portion of the Colorado remains virtually untouched.

In the narrow and barren inner gorge of the Grand Canyon, the Colorado River is a swift, silt-laden stream, subject to intense floods. It thus provides a habitat that fishes of usual body form can not resist, and a type of environment that has remained unexplored by collectors. While I was exam-

[1] Published by permission of the Secretary of the Smithsonian Institution. Received November 8, 1946.

ining the fish collection at Grand Canyon National Park in the fall of 1942, a single specimen obtained from this part of the Colorado River caught my attention. Subsequent study has shown it to be of unusual interest in possessing remarkable adaptations for life in torrential waters, and the specimen is now the holotype of the novelty described below.

No fewer than 12 nominal species referrable to the genus *Gila* have been attributed to the Colorado River fauna (Jordan, Evermann, and Clark, 1930, pp. 114, 119). Information now at hand indicates that no more than two species, *Gila robusta* and the novelty recognized herein, are known to inhabit the basin. None of the described forms has attained the extremes of specialization and the bizarre appearance of this new species.

Genus **Gila** Baird and Girard

Gila cypha, n. sp.

Fig. 1

Diagnosis.—A strongly compressed *Gila* with the sides of the body slightly convex and with a prominent abrupt hump over the occiput; body almost entirely devoid of scales (except for about 80 in lateral line) which have basal radii; fins expansive, falcate; snout fleshy; mouth inferior; eye very small.

Holotype.—The holotype (U.S.N.M. no. 131839) is a specimen about 305 mm in standard length and was taken by N. N. Dodge near Phantom Ranch in the western end of Grand Canyon National Park, Arizona. It was caught in swift water on hook and line, presumably in the nearby Colorado River at or near the mouth of Bright Angel Creek.

Nontypes.—A specimen (U.S.N.M. no 20083) in fair condition, but lacking data, is referred to the new species, and it is very reasonable to assume that it came from the Colorado River drainage, for cyprinid fishes of this type are known only from that basin. It is compared with the holotype in Table 1. Another specimen (U.S.N.M. no. 15349), represented only by the head, nape, and pectoral fins, and likewise without locality data, also is referred to the new species, for it bears the prominent, abrupt hump which is believed to characterize *G. cypha.*

Description.—The form and coloration of *Gila cypha* are portrayed in Fig. 1, and the proportional measurements are given in Table 1. The following description is of the holotype. Fin rays: Dorsal iii, 9, the first full-length ray unbranched and preceded by 3 graduated, rudimentary rays, the first one very small; anal iii, 11, the first full-length ray unbranched and preceded by 3 graduated, rudimentary rays; pectoral rays 18 in each fin; pelvic rays 9 in each fin; principal caudal rays 20, 18 branched plus a full-length unbranched ray above and below.

Scales in lateral line about 80, embedded and only slightly imbricated anteriorly and becoming more embedded and less imbricated posteriorly until those on the caudal peduncle are scarcely evident (drawn too clearly in Fig. 1). Scales above the lateral line deeply embedded and, for the most part, completely isolated from one another, not evident above the level of the base of the nuchal hump. Scales below the lateral line similar to those above, not evident below the base of the pectoral fin except in the region behind the pectoral fin. Back, breast, and belly completely devoid of scales. Dorsal and ventral surfaces of caudal peduncle completely smooth and scaleless, about three or four irregular rows of embedded scales above and below the lateral line anteriorly which taper off to only one or two such rows above and below the lateral line posteriorly. In degeneration of squamation, *Gila cypha* is closely approached by *Gila robusta elegans* Baird and Girard and, to a lesser extent, by *Gila robusta seminuda* Cope and Yarrow (herein tentatively recognized); the new species is exceeded in this feature by two unrelated genera of cyprinids, *Plagopterus* Cope and *Meda* Girard, in which scales are usually completely lacking. Other Colorado River fishes, such as the cyprinids *Ptychocheilus lucius* Girard and *Tiaroga cobitis* Girard, and the catostomid *Xyrauchen texanus* Abbott, also have lost some of their scales. This desquamation appears to have taken place in response to adaptation to a swift-water habitat, making the body surfaces smoother and thereby reducing friction. Most of these fishes also have well-streamlined bodies.

Total gill rakers nine on the left side, 11 on the right, short and dimorphic; those (two or three) on the upper limb and the one at the angle of the arch are slender, pointed, and

curved at the tip, whereas those on the lower limb are shorter and thicker and all but the most anterior ones are variously forked. All the rakers are attached anteriorly to the gill arch by a broad membrane. Pseudobranchiae weakly developed.

Dental formula 2, 5–4, 1?, three teeth (1 in main row, 2 in lesser row) missing on the left arch and one tooth (in main row) missing from the right arch, with the definite possibility that there is also one tooth missing from the lesser row of this arch (if so, the formula would be 2,5–4,2 as usual in *Gila*). The teeth in the main row are thick, especially toward the base, bluntly pointed, with a weak grinding surface on the first two. No doubt the teeth were modified during the lifetime of the fish, as is characteristic in cyprinid fishes. The only tooth remaining on the lesser row (right arch) is well developed, conical, and bluntly pointed.

The pharyngeal arches are unusually small for a fish the size of the holotype (approximately 305 mm, standard length). The total length of each arch, measured from the apex of the upper limb to the tip of the lower limb, is only 21.8 mm (left arch) and 22.7 mm (right arch). The total lengths of the arches of the largest cotype of *Gila robusta* Baird and Girard (=*G. r. robusta*, U.S.N.M. no. 246,[2] approximately 305 mm long) are 31.8 (left arch) and 32.6 (right arch)—10 mm. longer than the specimen of *Gila cypha* of the same length. In *cypha* the upper and lower limbs of each arch (measured from the base of the first and last teeth of the main row) are almost exactly equal, whereas in the cotype of *robusta* the lower limb of each arch is slightly longer. Both the upper and lower limbs are thicker in *cypha* than in the cotype of *robusta*. In U.S.N.M. no. 20083, tentatively referred to *cypha* (see discussion under Nontypes and Table 1), the total length of each arch is likewise short: 21.7 (left) and 21.2 (right), with the standard length of the specimen approximately 315 mm. Unfortunately, the pharyngeals of the only other specimen referred to the new species (a head, U.S.N.M. no. 15349, see under Nontypes) are missing.

In size and shape, the pharyngeals of the new species much more closely approach those of *G. robusta elegans*. In the type of *elegans* (U.S.N.M. nos. 251 and 20079,[3] a fish about 245 mm long) the total length of the left arch is 20.5 mm or about one-twelfth the standard length, as compared with about one-fourteenth this distance in the holotype of *cypha*. As in the new species, the two limbs of the arch are equal. The main difference between the left arch of *elegans* and that of *cypha* lies in the greater curvature of the upper limb and particularly the more compressed form of the lower limb in *elegans*. Thus the least width of the lower limb divided into the total length of the arch gave ratios of 1.5 (type) and 1.4 (U.S.N.M. no. 45404, see Table 1) in *elegans* as compared with ratios of 0.9 (holotype) and 1.2 (U.S.N.M. no. 20083) in *cypha*.

In coloration the holotype of *Gila cypha* (originally preserved in formalin, in which it remained for some time) is brownish—pinkish brown on the sides and belly and yellowish brown along the back. On close examination, most of the head, back, and sides above the level of the lateral line are densely covered with dark puncticulations; these extend below the lateral line in the region above and behind the pectoral base and near the base of the caudal fin. The same pigmentation occurs near the base of the first pectoral ray (left fin particularly), and also near the bases of the interradial membranes of the dorsal and caudal fins.

The following measurements were stepped off with a pair of precision dividers under a magnification of about 2½ times. Body depth in standard length, 4.25; head length in standard length, 4.1; head depth in head length, 1.5; head width in head length, 1.7; length of caudal peduncle about 3.3 in standard length; least depth of caudal peduncle in head length, 4.8, in base of dorsal, 2.8; length of snout in head length, about 2.7; eye in head, about 13.0, in least depth of caudal peduncle, about 3.0; dorsal and anal bases equal, 1.6 in head; length of pectoral almost equal to that of

[2] JORDAN and EVERMANN, 1896, p. 227, erred in giving the type the numbers 276, and 277 (which are codfish, according to the National Museum register).

[3] Reentered by error as U.S.N.M. no. 20079. Jordan and Evermann, 1896, p. 227, wrongly cited nos. 935 and 20265 as the type, Major Thomas as collector, and included the Colorado and Gila Rivers in the type locality. The single specimen was collected by Dr. Woodhouse in the Zuni River, N. Mex., a tributary of the Little Colorado River.

head; length of pelvic 1.4 in head length; length of longer (upper) caudal lobe much greater than head length and about 3.3 in standard length.

The only other entire specimen believed to represent *Gila cypha* (U.S.N.M. no. 20083, Table 1) differs principally from the holotype of *cypha* in having a deeper body (greatest depth about 3.7 rather than 4.25 in standard length), a larger eye (10.6 in head and 2.5 in least depth of caudal peduncle, rather than 13.0 and 3.0), and a somewhat greater extent and better development of squamation. The scales above the lateral line are particularly less degenerate in this specimen than in the holotype, though they are embedded and are posteriorly isolated from each other (as nearly everywhere in the type). They are developed up to about a level with the middle (rather than the base) of the nuchal hump. Below the lateral line the scales are only very slightly better developed than in the holotype As in that specimen, the back, breast, and belly are devoid of scales except for a few exceedingly minute and deeply embedded ones scattered at random over the back, particularly anteriorly. The dorsal and ventral parts of the caudal peduncle are also smooth and lack scales, except for a few minute remnants. There are about six or seven (rather than three or four) irregular rows of embedded scales anteriorly above and below the lateral line along the caudal peduncle which taper off to three or four (rather than one or two) nearly indistinguishable rows posteriorly. The other differences in measurements (Table 1) between this specimen and the holotype of *cypha* lie within the expected range of intraspecific variation.

Comparisons.—Gila cypha obviously belongs to the subgenus *Gila*, as recently tentatively defined (Miller, 1945, p. 104), even though its small scales, which lack a basal shield, have basal radii in addition to apical and lateral radii; the teeth are 2,5–4,2 (in U.S.N.M. no. 20083; perhaps only 2,5–4,1 in holotype), and the dorsal origin is behind the insertion of the pelvic fins. The only other species of this subgenus which I now recognize from the Colorado drainage is *G. robusta* Baird and Girard. In the paper cited above, I listed *Gila elegans* Baird and Girard separately, with the suggestion (long ago advocated by Dr. Carl L. Hubbs) that it probably represents an ecological subspecies of *robusta*. I am convinced that *robusta* and *elegans* are only subspecifically separable, for the five types of *Gila seminuda* Cope and Yarrow (U.S.N.M. no. 16975) seem to close the gap between those nominal species (Table 2). It is therefore necessary to compare *cypha* only with *robusta*, *minacae* Meek, and *nigrescens* (Girard), the other species of the subgenus *Gila*.

The new species differ sharply from those three species and from all of the subspecies of *robusta* (as tentatively diagnosed in Table 2), except *r. elegans*, in having very degenerate squamation, expansive falcate fins, a dorsoventrally flattened head, an inferior mouth and a long fleshy snout. In these features *cypha* is closely approached by *G. r. elegans*,

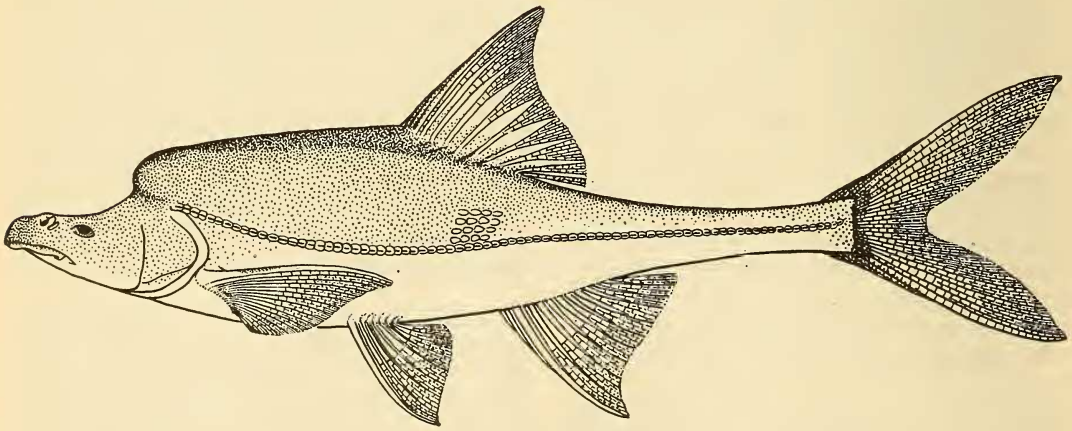

FIG. 1.—*Gila cypha*, n. sp.: Holotype (U.S.N.M. no. 131839), 305 mm in standard length. Drawn by Mrs. A. M. Awl.

the swift-river representative of the *robusta* series commonly called "bony-tail" because of the hard, pencil-shaped caudal peduncle. The most conspicuous difference between *cypha* and *r. elegans* is the prominent nuchal hump for, although I have examined 80 specimens of *elegans* from the lower Colorado River (Grand Canyon to Baja California), representing yearling to very large adults (up to 385 mm standard length), none of these has shown more than a broad, even convexity in the nuchal region. The degeneration and disappearance of the scales is far more advanced in *cypha* than in typical *elegans* for in the "bony-tail" only the back, breast, belly, and upper and lower surfaces of the caudal peduncle may be naked, whereas most of the body and nearly the entire peduncle are naked in the holotype of *cypha*. The scales of *G. r. elegans* also seem to lack basal radii, for in 26 specimens examined for this character I found only apical and lateral radii developed. The scales examined were taken from the region just above or below the lateral line, directly above the base of the pelvic fins, preferably on the right side of the body.

Comparative measurements between *cypha* and *G. r. elegans*, given in Table 1, indicate strong to slight differences in certain features. The reliability of these data, however, is lessened by the few specimens involved and perhaps also by the possibility of sex-correlated characters. The deeper but narrower body and head, slightly longer snout, smaller eye, and greater distance between the origin of the anal fin and the base of the caudal fin in *cypha* are characters which probably do not show sex dimorphism. The greater size of all of the fins in this species, however, as compared with *elegans*, might be solely an expression of maleness. On the other hand, the more expansive fins may be the result of adaptation to swift water, thus providing the species with stronger appendages for resisting the current. It is indeed unfortunate that the body cavities of the two specimens of *G. cypha* are eviscerated,

TABLE 1.—PROPORTIONAL MEASUREMENTS OF GILA CYPHA AND GILA ROBUSTA ELEGANS

Character	*Gila cypha*		*Gila robusta elegans*[1]		
	Holotype	U.S.N.M. 20083	U.S.N.M. 45404	U.S.N.M. 936	U.S.N.M. 76386
Standard length, mm	305±	315±	318±	325±	338±
Measurements in thousandths of the standard length:					
Dorsal origin to tip of snout	479	487	465	485	484
Pelvic origin to tip of snout	409	429	409	405	426
Anal origin to caudal base	441	422	419	408	424
Body, greatest depth	239	276?	222	199	185
Greatest width	117	131?	154?	150	140±
Head, length	237	237	243	228	239
Depth	160	169	131	114	129
Width	127	129	151	143	151
Caudal peduncle, length	298	276	259	289	294
Least depth	50	51	44	37	37
Interorbital, least bony width	83	85	89	85	84
Opercle, greatest length	74	70±	73	72	73
Snout, length	85?	89	79	73	81
Eye, length	19	24?	29	25	25
Orbit, length	26±	31?	33	31	32?
Mouth, width	89?	101?	92?	85	95?
Upper jaw, length	89	102	86	78	86
Mandible, length	87	89	90	83	89
Dorsal fin, depressed length	225	220?	214	204	201
Basal length	145	151	141	138	134
Anal fin, depressed length	221	211	186	181	187
Basal length	144	149	146	125	134
Middle caudal rays, length	87	90?	93	80	—
Upper caudal lobe, length	305±	—	247?	226	—
Pectoral, length	225	219	201	192	198
Pelvic, length	176	183	157	150	148
Sex	?[2]	?[2]	♀?	♀	♀

[1] Material from the lower Colorado River at and near Yuma, Ariz.
[2] Eviscerated.

making positive sex determination impossible.

The *Gila robusta* complex provides a fine example of correlation between ecology and morphology (Table 2). This remarkable correlation can only receive passing notice at this time for the problem has not been studied in detail and much more material, especially from the main Colorado, is needed. The small tributary and brook subspecies, *intermedia*, has a chubby body with comparatively large scales, small and rounded fins, and a comparatively deep caudal peduncle. The large tributary and smaller river form, *robusta*, has a more streamlined body with smaller scales, larger and slightly falcate fins, and a more slender caudal peduncle. The swift river-channel subspecies, *elegans*, is extremely well streamlined, with embedded scales (often absent on back and elsewhere) forming little resistance to the current, expansive and strongly falcate fins (caudal fulcra excessively developed), and a terete, pencil-shaped caudal peduncle.

The apparent end form of this series seems to be represented by the highly specialized *Gila cypha*, which, on the basis of the inadequate material at hand, cannot be aligned as a subspecies of *robusta*. If the trend in characters from *intermedia* to *elegans* shown in Table 2 continued beyond the *elegans* level, the next form would be expected to have at least 11 dorsal rays and a narrower caudal peduncle than *elegans*. The two specimens of *G. cypha* have, unexpectedly, only nine dorsal rays, and the caudal peduncle is deeper than it is in *elegans* (Tables 1 and 2). Moreover, the scales of the new species bear basal radii whereas those of *elegans* have only apical and lateral radii. In this character, *cypha* agrees with the otherwise very different looking *G. r. intermedia*. Both *G. cypha* and *G. r. elegans* occur in the main Colorado River although the precise ecologic niche for each form has not been determined. The scanty available data indicates that *elegans* collects at the mouths of the clear

TABLE 2.—PROVISIONAL COMPARISON BETWEEN SUBSPECIES OF GILA ROBUSTA AND GILA CYPHA[1]

Character	Subspecies of *G. robusta*				*G. cypha* (2 specimens)
	intermedia[2]	*robusta*[2]	*seminuda*[3]	*elegans*[4]	
Dorsal rays	8 (rarely 7 or 9)	9 (rarely 8 or 10)	9 or 10	10 or 11	9
Anal rays	8 (7–9)	9 (rarely 7, 8 or 10)	9 or 10	10 or 11	10 or 11
Pelvic rays	8–8 (frequently 9–9)	9–9 (rarely 10–10)	9–9 or 10–10	9–9 (rarely 10–10)	9–9
Scales	Fully scaled; 65–87 in lateral line; basal radii usually present	Fully scaled; 79–96 in lateral line; basal radii infrequent (rarely well developed)	Back, breast and belly naked in some; 77–89 in lateral line; 2 out of 5 with very faint basal radii	Back, breast, belly and much of caudal peduncle often naked or with minute, deeply-embedded scales; 75–88 in lateral line; no basal radii	Most of body naked; 77–80 in lateral line; basal radii moderately to well-developed
Nuchal hump	Absent	Slightly arched in very large fish[5]	Absent in material examined[3]	Moderate to high but evenly arched in larger specimens	Prominent, truncate anteriorly
Least depth of caudal peduncle into head length	2.6–3.4	3.3–4.3	4.1–5.2	5.0–6.5	4.6–4.7

[1] The counts and measurements recorded here for the subspecies of *robusta* have been jotted down over a period of five years during routine identification and examination of collections from the Colorado River drainage.

[2] Material from the Gila River Basin only.

[3] Based on the five types, 90 to 128 mm in standard length, U.S.N.M. no. 16975, which may be regarded either as intergrades between *robusta* and *elegans* or as an intermediate subspecies (as tentatively done above, as also by Ellis, 1914, p. 57).

[4] Material from the Middle and Lower Colorado only (Little Colorado to mouth of Colorado).

[5] Exaggerated in the drawing of one of the types of *G. robusta* (U.S.N.M. no. 246, largest fish) shown in Sitgreaves (1853, pl. 1, fishes).

tributaries and it has been taken some distance up the larger tributaries.

Habitat and associates.—Some conception of the rate of flow of the swift, silty Colorado River can be gained by records of the gauging station approximately 240 miles below Grand Canyon. Over the period 1917 to 1926, this rate varied between 1,800 and 174,000 cubic feet per second, with a variation between low and high water stages of about 25 feet (Thompson, 1929, p. 733). Dangerous rapids are interspersed throughout the Colorado River, especially in the Grand Canyon region, and have proved treacherous, and often disastrous, barriers to explorers of the river. Because of the scouring action of the river no vegetation can exist.

Judged from its large, falcate fins, specialized nuchal hump, inferior mouth, and dorsoventrally flattened head, *Gila cypha* is well adapted for life in the swift current very near or on the bottom. The action of the current against the prominent nape tends to force the fish down toward the bottom or the sides, where the flow is not so torrential as in midwater. The small eye may represent a degeneration correlated with reduced light due to the excessive silt, or it may be a response to the direct effect of the scouring action of the suspended matter, or both.

No scientific survey of the fishes of Grand Canyon National Park has been undertaken, but fish have been caught occasionally by angling and these few specimens (deposited in the Park collection) give an idea of the associates of *Gila cypha*. Among them are the humpback sucker, *Xyrauchen texanus* (Abbott), the mountain sucker, *Pantosteus delphinus* (Cope), *Gila robusta elegans* Baird and Girard, and the introduced channel catfish, *Ictalurus lacustris punctatus* (Rafinesque). Two others are to be expected in the main river as both occur elsewhere in the Colorado and are adapted for channel life: the flannelmouth sucker, *Catostomus latipinnis* Baird and Girard, and the Colorado squawfish or "salmon," *Ptychocheilus lucius* Girard, reputed to be the largest cyprinid fish in the New World (Jordan and Evermann, 1896, p. 225).

Range.—*Gila cypha* is known definitely only from the Grand Canyon near the mouth of Bright Angel Creek. The only other specimens referred to the new species are without locality data. The species may be found to be common in the main channel of the Colorado in Grand Canyon when that swift-water habitat is thoroughly collected. It may not occur below Boulder Dam, for I have seen a number of collections from that area and all the *Gila* therein are referable to *G. r. elegans*.

Etymology.—The specific name *cypha*, suggested by Dr. Carl L. Hubbs, is from the Greek κυφή, meaning hump-backed, in reference to the striking nuchal hump.

Acknowledgments.—It is a pleasure to thank the authorities of Grand Canyon National Park, and particularly Park Naturalist Louis Schellbach, for allowing me to describe this novelty and for donating the holotype to the U. S. National Museum. Through the efforts of Mr. Schellbach a start has been made on a check-list of the fishes of the Park, and some of this material has been included in the present report.

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